**Probability & Applications of Simulations**

**Brief Overview:**

This lesson revolves around developing the concepts of probability, defining probability, simulations and the tools and rules used to simulate the probability of such events. By the end of the lesson, students should understand the basic concepts of probability and how to conduct simulations using the different tools discussed.

**NCTM Content Standard/National Science Education Standard**:

Data Analysis and Probability

- Use simulations to construct empirical probability distribution.
- Compute and interpret the expected value of random variables in simple cases.
- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- Collect data using observations, surveys, and experiments.
- Understand and apply basic concepts of probability.
- Describe events as likely or unlikely and discuss the degree of likelihood using such words as certain, equally likely, and impossible. Predict the probability of outcomes of simple experiments and test the predictions;
- Understand that the measure of the likelihood of an event can be represented by a number from 0 to 1.

**Grade/Level:**

Grades 8–10, Algebra I

**Duration/Length:**

Three 50 – 80 minute class periods

**Student Outcomes:**

Students will:

- Students will be able to determine appropriate uses for a variety of simulation tools in order to conduct trials and determine outcomes of several different events.

- Students will have the foundation behind probability involving simulations in order for them to create, design and execute simulations for a variety of situations.

**Materials and Resources:**

- PowerPoint & LCD Project
- TI–83 or TI–84 Graphing Calculator
- 10–sided number cube
- Spinner
- Coins
- Playing Cards
- Jolly Ranchers and paper bags.
- White Boards
- Worksheets
  - 'I Have, Who Has" Cards
  - Entrance Ticket (For lesson 2)
  - Simulation Station
  - Introduction to Designing Simulation
  - Let's Race Simulation

**Development/Procedures:**

Lesson 1

Preassessment –Since students have had some experience with basic probability in earlier grades, we can use a small probability activity. Activities that are to be used are identifying the probability of rolling an odd number on a number cube. Also, students can calculate the probability of pulling out a red card in a standard deck of cards.

Launch – Explore the new concept with the students, motivating them to experience it for the first time. Exploring the concept can include a deck of playing cards, bag of candies/marbles, a coin, and a number cube. Using the aforementioned items students will explore how probability is associated with these different items. Preassessment may be embedded in the launch.

Teacher Facilitation – Use the Power Point presentation to explore probability and incorporate student experiences in direct instruction.

Student Application – Students will take notes along with the Power Point presentation, answering questions, checking their work, and contributing to the power point.

Embedded Assessment – After the Power Point, have the class will play "I Have, Who Has?" in order to practice probability terms and simple computations. Homework will be assigned from the textbook on simple probability and vocabulary.

Re-teaching/Extension –

- The second lesson will cover the first lesson's concepts thoroughly. The teacher will have opportunities for individual students during the second lesson.
- The concept of fair game can be explored through looking at a version of the Rock, Paper, Scissors game

Lesson 2

Preassessment– Students possess the knowledge of the basic concepts of probability, the definition, experimental probability versus theoretical probability, the Law of Large Numbers and simulation tools available. Students should begin to think about the different ways to implement the use of simulations. In order to determine the level of knowledge the students now possess, an Entrance Ticket will be given at the beginning of Lesson 2.

Launch– As the students come into class, have them begin the "Entrance Ticket (Lesson 2)". The Entrance Ticket will assess the understanding of the material from the first lesson. On the top of each entrance ticket, the students will have a number from 1–10 and a color blue or yellow listed under the number. Once students have completed the entrance ticket, roll a 10–sided number cube twice for each question to help choose who will answer each question. This will narrow the class to two students for the answer. Then, spin a two–section colored spinner; whatever color it lands on that person will give the answer.

Teacher Facilitation– The basic background information about each simulation tool and probability was covered in the notes of Lesson 1. During this lesson, the teachers' role is to assign each student a group of 3 to 4 people to work with while completing six stations. The teacher will explain the directions for the stations.

Student Application– Students will break into their groups, go to the assigned simulation station and begin working.

Embedded Assessment– During the Simulation Station Activity, the teacher will be walking around the room making sure all of the students are on task and working together, and answer any questions that the students may have. The kids will be assessed informally by using a participation grade for this group work lesson. After the activity, the teacher will collect each student's paper and choose one section to grade for correctness and this will be a classwork grade for the day.

Re-teaching/Extension–

- After the station activity have each student turn in their work. Pass out white boards to each student and choose questions from the Simulation Station to ask the class. Have them put the responses on white boards. This is a quick way to pick out students who do not understand the material and allow you to see what needs to be reviewed the next day.
- **The Stations may flow into a second day. Please allow time for the Stations in the following day.**

Lesson 3

Preassessment– Students will have a solid foundation of the different simulation tools and the ways in which they are used. They analyzed outcomes of situations based on results from the simulations they designed and executed. In order to understand what student's perception of random number generators are, the drill for the day will be to ask what they think their chances are of winning the lottery if they played the Mega Millions that Friday. We can discuss the probability of winning the lottery and how the numbers for the lottery are generated. This will be followed by the launch activity that demonstrates the concept of a random number generator.

Launch– As the students come into class, use the random number generator on the TI–83 graphing calculator to generate three numbers from 1–30 depending on the size of your class. Each child in the class has a number on their desk and this is the number they will reference. When everyone is sitting down, place a piece of candy on the students whose desk has one of the numbers that are on the screen. Ask the kids how they think the calculator came up with those numbers. After some feedback, ask the kids if they think any of the numbers will appear again. Then, generate more random numbers until at least one of the numbers appear on the screen again. This will illustrate the use of the random number

generator on the calculator and show that each number has an equal chance of appearing and it could appear more than once.

Teacher Facilitation– Ask the kids if they have ever gotten a prize in a kid's meal at a restaurant. Then, ask for about five volunteers to come to the front of the room. Explain that we will be simulating getting one of each prize in a five set series of toys. Have each student pick a prize out of the bag without looking. Record which one was chosen on the chalkboard, replace the toy and have the next person choose a prize. Complete this activity until one of each was chosen. Pose the question, "Do you think this is the fastest way to simulate getting all five prizes in the series?" Then explain that a random number generator on the calculator is the fastest way to simulate this situation.

Pass out the worksheet, "Introduction to Designing Simulation." **Walk the students through the simulation while you all complete it together.**

Student Application - After the student's complete "Introduction to designing simulation", pass out "Let's Race Simulation" Worksheet and have the students work with their neighbor to complete this simulation.

Embedded Assessment– After the students complete the last activity, combine all of the frequencies for the data of each group and discuss the outcomes.

Re-teaching/Extension– On day two of lesson 3, have the kids try the Cereal Box Activity by George Reese at http://www.mste.uiuc.edu/reese/cereal/intro.html. Students could also complete this activity as an extra credit assignment or use it as a class project.

**Summative Assessment**:

At the end of the three-day lesson, students will be able to successfully design, execute and explain a simulation that they will create using several different simulation tools. This allows the teacher to assess the understanding and application of the material and include appropriate accommodations for the students who may be

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